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Dear *Permission to be Powerful* Reader…

What if life isn't rare?

What if it's common — and the loneliness we've all felt is just a temporary illusion, waiting to be shattered by new light?

The exoplanet K2-18b might be where that light first breaks through.

NASA's James Webb Telescope just gave us our clearest hint yet that a planet beyond our solar system may host life-linked molecules.

Specifically, dimethyl sulfide (DMS) and dimethyl disulfide (DMDS), gases known on Earth to come only from living organisms.

Below is the full breakdown — the evidence, the debate, the doubt, and the awe.

But at the core of it all is one quiet possibility:

We may not be alone. Not even close.

Artist's impression of exoplanet K2-18b (right) orbiting its red dwarf star (left). This "sub-Neptune" world is about 2.6 times Earth's radius and lies ~124 light-years away, within its star's habitable zone. Scientists are investigating whether it harbors a hydrogen-rich atmosphere over a liquid ocean.

Introduction: K2-18b and the Search for Life

Astronomers have uncovered intriguing clues that **exoplanet K2-18b** – a mini-Neptune orbiting a cool red dwarf – might host molecules associated with life in its atmosphere.

A research team from the University of Cambridge, using data from NASA's *James Webb Space Telescope* (JWST), detected the chemical

signatures of dimethyl sulphide (DMS) and dimethyl disulphide (DMDS) in K2-18b's air 1.

Both of these gases on Earth are produced only by living organisms, specifically marine phytoplankton and bacteria 2

The discovery was made alongside clear detections of methane (CH_4) and carbon dioxide (CO_2) on K2-18b3 – a combination that had already hinted this planet could be a "Hycean" world with a hydrogen-rich atmosphere and possibly a global ocean beneath4.

K2-18b is about 8.6 times the mass of Earth

(2.6 times Earth's radius)

And orbits within the habitable zone of its star.

Meaning it receives a similar amount of starlight as Earth does from the Sun.5

Previous observations of this planet had identified water vapor in its atmosphere, attracting interest to its potential habitability.

JWST's superior sensitivity now allows scientists to probe the atmosphere in unprecedented detail – and the possible detection of DMS and DMDS marks the strongest hint of biological activity beyond our solar system 6.

"This is the strongest evidence yet that there is possibly life out there," says Prof.

Nikku Madhusudhan, the Cambridge astronomer leading the team 7.

However, he and other experts caution that more data are needed to confirm the finding, and they stress that non-biological processes could produce similar signals . I

n the sections below, we summarize the findings, why these molecules excite astrobiologists, the scientific debate surrounding them, and how JWST enabled this breakthrough.

Detection of Life-Linked Molecules on K2-18b

The Cambridge team analyzed K2-18b's atmospheric spectrum obtained by JWST during transits (when the planet passes in front of its star).

In 2023, JWST's near-infrared instruments (NIRISS and NIRSpec) had already revealed abundant methane and carbon dioxide in the planet's atmosphere 8 – consistent with an ocean-bearing Hycean world – and even showed a tentative hint of dimethyl sulfide (DMS) 9

That initial DMS signal was very weak (on the order of a "1-sigma" result, ~68% confidence), so it was not taken as evidence of life. Now, the team has followed up with JWST's mid-infrared instrument (MIRI), which covers longer wavelengths where DMS/DMDS have distinct spectral features.

The new 6–12 μm transmission spectrum of K2-18b showed clear spectral features – it is *not* a flat line – indicating some additional gas is present 10.

By comparing the data with models, the scientists found that no common atmospheric molecule (aside from DMS or DMDS) could explain the observed features 11.

In fact, the best fit to the spectrum requires a high abundance ($\gtrsim$10 parts-per-million by volume) of either DMS or DMDS (or both) in the atmosphere 12.

Importantly, this new detection is still statistically "tentative." The signal corresponding to DMS/DMDS has a confidence level of about 3-sigma (≈99.7% certainty) 13. In scientific terms, this means there is still a ~0.3% chance that the result is a statistical fluke (false positive).

By convention, a 5-sigma (99.9999%) confidence is typically required to claim a definitive discovery in astronomy 14.

"While the present evidence is not as strong as that for CH_4 or CO_2, it is much greater than the hint we had 18 months ago,"

the team notes, referring to the improvement from a 1σ blip to a 3σ signal .15

In other words, the evidence for DMS/DMDS on K2-18b has strengthened, but it falls short of the threshold for a conclusive detection.

Despite this, the results are compelling because if DMS (or DMDS) truly exists in K2-18b's atmosphere, it would be the first time a gas potentially indicative of life has been found on a planet outside our solar system. The amount detected is also striking.

"The amount we estimate of this gas in the atmosphere is thousands of times higher than what we have on Earth," notes Prof. Madhusudhan 16.

"So, if the association with life is real, then this planet will be teeming with life," he told the BBC17

.

Such a high concentration of a life-related gas raises the tantalizing possibility that K2-18b's hypothetical ocean could harbor abundant microbial life continuously emitting these molecules.

Madhusudhan goes so far as to say that if life on K2-18b is confirmed, *"it should basically confirm that life is very common in the galaxy"*18 – a profound implication.

However, he emphasizes that this bold claim is not yet proven.

The team is optimistic that additional JWST observations in the next "one to two years" will be able to confirm the signal definitively 19, but until then, it remains a candidate sign of life rather than a confirmed discovery.

Why DMS and DMDS Suggest Possible Biology

What makes the detection of dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) so noteworthy is that on Earth these gases are only produced by life. DMS is a volatile organosulfur compound with a distinctive odor (sometimes described as a cabbage or seaweed smell) and it is abundant in Earth's marine atmosphere.

Crucially, DMS has no significant abiotic (non-living) source on modern Earth – virtually all of it comes from biological activity . The main producers of DMS on Earth are marine microorganisms: phytoplankton in the oceans produce a precursor compound (dimethylsulfoniopropionate, DMSP) which is broken down into DMS, and certain bacteria also generate DMS during the decay of organic matter.

In fact, the bulk of the DMS in Earth's atmosphere is emitted from ocean-dwelling phytoplankton 20. This makes DMS a compelling candidate as a biosignature gas – if you detect abundant DMS in a planet's atmosphere, it strongly hints at biological activity (at least under Earth-like chemistry), because we know of no geochemical process that pumps out DMS at high levels.

Dimethyl disulfide (DMDS) is closely related to DMS – it essentially contains two linked sulfur atoms instead of one. DMDS is also common in Earth's sulfur cycle and is often found wherever DMS is present, since it can form from the oxidation or combination of DMS molecules.

Like DMS, DMDS is primarily associated with biological sources on Earth: it is emitted by certain bacteria, fungi, and phytoplankton, often as a metabolic byproduct or during the decomposition of organic sulfur compounds .21

In short, both DMS and DMDS are naturally produced by living organisms (plants, microbes, and animals) and not by inert geology. This is why finding evidence of these molecules on another planet is so provocative – it suggests the possible presence of active biological processes there.

On K2-18b, the hypothesis is that if the planet indeed has a vast liquid-water ocean under a hydrogen-rich sky (the Hycean world scenario), it might host microbial life in that ocean analogous to Earth's marine microbes.

Those alien microorganisms (if they exist) could be releasing DMS (and DMDS) into the atmosphere, just as ocean phytoplankton do on Earth 22.

The atmospheric composition found by JWST (methane and CO_2 with little ammonia) is consistent with an ocean-bearing world and even hints that if life were present it might be metabolizing nitrogen (consuming ammonia) 23. Dr. Subir Sarkar, a member of the Cambridge team, noted that their research

"suggests K2-18b could have an ocean which could be potentially full of life" –

though he quickly added that scientists…

"don't know for sure" yet if that is the case 24.

The presence of DMS/DMDS is one piece of evidence that, in combination with the planet's environment, raises the possibility of an ocean teeming with microbial life .25

This is why the discovery is being met with excitement: it's the first time we've seen a credible hint of *biologically relevant gases* on a distant exoplanet's atmosphere.

However, it's critical to remember that correlation is not confirmation. We know DMS and DMDS are linked to biology on Earth, but K2-18b is an alien world – could there be some exotic non-biological mechanism

producing these molecules there? The Cambridge team and others are now exploring that question, which leads into the current scientific debate.

Scientific Debate: Caution and Alternative Explanations

Extraordinary claims require extraordinary evidence. While the possible detection of DMS/DMDS on K2-18b is intriguing, scientists are approaching the result with healthy skepticism until more proof is obtained.

The signal is currently a 3σ result, meaning it has a 99.7% probability of being real . 26

That might sound convincing, but by scientific standards it is not yet strong enough to claim a discovery. Typically, a 5σ confidence (99.9999%) is required to deem a detection definitive .27

Prof. Nikku Madhusudhan underscores this point: there is still a 0.3% chance the DMS/DMDS signal is just a statistical fluke, and *“we want to be*

really, really thorough, and make more observations" to push the certainty to the million-to-one level .28

Until additional JWST observations confirm the signal at high significance, the team is not claiming they have found life, only that they have found a possible marker that warrants further study 29.

Even if DMS is firmly detected on K2-18b, scientists caution that this alone would not prove the gas is of biological origin. Prof. Catherine Heymans, an astronomer at the University of Edinburgh (not involved in the research), points out that

"on Earth it is produced by microorganisms in the ocean, but even with perfect data we can't say for sure that this is of a biological origin on an alien world"30

The universe might surprise us with "strange geological activity" or chemical pathways that could generate the same molecules without life .31

In other words, we must rule out all plausible abiotic sources of DMS/DMDS on K2-18b before concluding that life is the cause.

This is a lesson learned from past "false alarms" in the search for life – for example, the debated detection of phosphine on Venus or methane on Mars, which initially hinted at life but later got alternative chemical explanations or were found to be uncertain.

"We've got to be very careful about claiming that this is 'a moment' in the search for life. We've had such moments before," says Prof. Chris Lintott, a University of Oxford astronomer and presenter of the BBC's *The Sky at Night*, urging caution .32

He admires the Cambridge team's work, but suggests viewing it as *"part of a huge effort to try and understand what's out there in the cosmos,"* rather than as a final breakthrough.33

The Cambridge researchers themselves openly acknowledge all the "ifs and buts" at this stage 34.

They have already begun collaborating with other research groups to investigate non-biological pathways that could produce DMS or DMDS under K2-18b-like conditions.

For instance, could certain photochemical reactions in a hydrogen-rich atmosphere generate DMS from inorganic ingredients?

Or might volcanic/geothermal processes on a water-rich planet release organosulfur compounds?

As of now, no known abiotic process on Earth generates large amounts of DMS/DMDS, but scientists are testing if unusual chemistry could do it on K2-18b 35.

Intriguingly, recent studies have suggested that DMS *might* be produced abiotically under certain conditions – for example, through high-energy chemistry in the atmosphere 36.

These studies, while not yet conclusive, remind us that we must keep an open mind. The Cambridge team plans laboratory experiments to see if DMS and DMDS can be synthesized without life in "Hycean" planet conditions 37. If those experiments fail to find an abiotic source, and the gas detection is confirmed, the biological hypothesis will look stronger.

There is also a broader scientific debate about the nature of K2-18b itself, which feeds into how we interpret the atmospheric signals.

The current data (methane, CO_2, no ammonia, possible DMS) suggest a world with an ocean under a hydrogen atmosphere, but not all scientists agree on that picture. Some astronomers propose alternative, non-life-bearing scenarios for K2-18b that could still be consistent with the observations.

For example, Prof. Oliver Shorttle (University of Cambridge) and colleagues have argued that K2-18b might not have a water ocean at all, but instead an ocean of molten rock (magma) on its surface 38.

In that scenario, the absence of ammonia in the atmosphere would be explained by ammonia dissolving into a hot magma ocean rather than a water ocean 39.

A magma-ocean planet could appear superficially similar in atmospheric composition, but it would be far too hot and hostile for life – effectively ruling out a biosphere, despite the atmospheric gases.

Another hypothesis, put forward by Dr. Nicolas Wogan (NASA's Ames Research Center), is that K2-18b is actually a "mini gas giant" – essentially a small Neptune-like planet with a deep hydrogen/helium envelope and no solid or liquid surface at all .40

If K2-18b is a mini-Neptune, it may not have a definable ocean where life could reside; its atmosphere could be a turbulent mix without a surface-ocean interface.

These competing interpretations underscore that we're still trying to pin down the basics: *Is* K2-18b a water-world, or something more like a scaled-down Neptune? The answer greatly influences how we assess the potential for life.

Notably, both the magma-ocean and mini-Neptune theories have been challenged by other researchers, who argue they don't fit all the JWST data 41. The fact that multiple theories exist "on the table" highlights the intense scientific controversy surrounding K2-18b at the moment 42.

"With K2-18b, part of the scientific debate is still about the structure of the planet," one scientist observed [43].

All sides agree that more observations are needed to distinguish these scenarios.

"Everything we know about planets orbiting other stars comes from the tiny amounts of light that glance off their atmospheres," the scientist explained [44].

"It is an incredibly tenuous signal that we are having to read, not only for signs of life, but for everything else." [45]

In other words, we're squeezing information out of very faint data, so it's no surprise that different interpretations can arise.

Further research is critical to resolve these debates. The Cambridge team is already scheduled to get more JWST transit observations of K2-18b in upcoming observation cycles [46].

Those should improve the signal-to-noise ratio of the spectra and hopefully either confirm the DMS/DMDS feature at high significance or reveal it to be a false signal.

Prof. Madhusudhan expects that within a year or two, they will have enough data to know for sure whether DMS is present [47].

If the signal strengthens to 5σ, the case for some kind of active source (potentially life) will be much stronger.

In parallel, ongoing lab experiments and atmospheric modeling will attempt to find any non-biological production routes for these molecules .

If none are found plausible, and the detection holds, then by elimination a biological source might be the best explanation.

Additionally, scientists will look for other signs in K2-18b's atmosphere to build a consistent story – for example, the presence of certain compounds or temperature profiles that might indicate an ocean vs. a magma surface.

The search for complementary biosignatures (like *methyl chloride*, another gas hinted in some data, or certain combinations of gases out of chemical equilibrium) will also continue.

It will likely take multiple lines of evidence before the community would be convinced that life has been found on K2-18b.

For now, the findings mark an *exciting but tentative step* toward answering the age-old question:

Are we alone?

Researchers generally agree that, at the very least, this result "marks a significant step in our quest" to find life elsewhere48, even as the debate continues 49.

Below is a summary of the two life-associated molecules in K2-18b's atmosphere, their significance, and what's needed next:

Molecule DetectedEarth-Based OriginDetection ConfidencePossible InterpretationsRequired Confirmation StepsDimethyl Sulfide (DMS)Produced almost exclusively by marine phytoplankton and bacteria (biological activity) 50. No known significant abiotic source on modern Earth.

Tentative 3σ detection (99.7% confidence) in K2-18b’s atmosphere 51.

First hint seen in 2023 data; stronger evidence in 2025 JWST spectrum52.

Biological origin?

On Earth, a potential biosignature of ocean life.

Could indicate microbial life releasing DMS on K2-18b if no other source exists. Non-biological?

Unknown abiotic chemistry might produce DMS under exotic conditions (subject of investigation).53

More JWST observations to boost confidence to 5σ (planned within ~2 years) 54. Laboratory experiments to test if DMS can form inorganically under K2-18b-like conditions55.

Cross-checks for additional biosignatures or inconsistent chemistry to validate life vs. non-life scenarios.Dimethyl Disulfide (DMDS)Emitted by bacteria, algae, and other organisms as a metabolic byproduct (often alongside DMS) 56. Part of the natural sulfur cycle (e.g. from decay of organic matter).

Tentative 3σ detection (degenerate with DMS signal) 57. Likely present if DMS is present, given they are chemically linked. Not yet separately distinguishable in data.

Biological origin?

Would imply similar source as DMS – active biology (microbes) in an ocean environment 58. DMDS could be a product of DMS oxidation, reinforcing a life-driven sulfur cycle. Non-biological?

No known abiotic source identified; possibly formed from DMS via atmospheric reactions, so an abiotic DMS source would also yield

DMDS.Higher-resolution spectra to distinguish DMDS from DMS features (future JWST or other telescopes).

Repeat detections to confirm its presence. Same lab studies as DMS – if DMS can be made abiotically, DMDS might follow, but if not, a biological origin is more likely 59

The Role of JWST: A New Era in Exoplanet Life Detection

This tantalizing finding was only possible because of the capabilities of the James Webb Space Telescope, which represent a major leap forward in the search for extraterrestrial life.

JWST, launched in 2021, is the first observatory powerful enough to directly detect molecular signatures in the atmospheres of small, habitable-zone exoplanets like K2-18b.

In the past, instruments like the Hubble Space Telescope could infer basic components (e.g. water vapor on K2-18b was reported in 2019), but JWST's large 6.5-meter mirror and advanced infrared spectrographs allow for much more detailed and sensitive measurements.

As team member Subhajit Sarkar noted, *"we have obtained the most detailed spectrum of a habitable-zone sub-Neptune to date, and this allowed us to work out the molecules that exist in its atmosphere.*60*"*

With JWST's data, scientists could clearly detect methane and CO_2 at high confidence 61 something not achievable previously on a planet of this size, and now are pushing to detect more elusive compounds like DMS in the mid-infrared62.

JWST's broad wavelength coverage (from ~0.6 μm to 12+ μm in this case) is crucial – for example, the suspected DMS/DMDS features occur at mid-infrared wavelengths that Hubble or ground telescopes cannot effectively observe.

JWST also observes with unprecedented stability and precision, enabling it to discern the slight dimming and color change of starlight as it filters through a planet's atmosphere during transit.

The detection of DMS/DMDS is essentially a tiny absorption imprint in the star's light caused by these molecules – a very subtle effect that only a telescope of JWST's caliber can tease out from the noise.

Many astronomers have praised JWST's performance in this regard, marveling that we can even attempt to detect such faint biosignatures at interstellar distances. 63

Prof. Madhusudhan highlighted that JWST is expanding our exploration beyond Earth-like planets: *"Traditionally, the search for life on exoplanets has focused on smaller rocky planets, but the larger Hycean worlds are significantly more conducive to atmospheric observations."* 64

With JWST, these Hycean candidates like K2-18b – which don't exist in our solar system – have become accessible targets in the quest for life.

These sub-Neptunes are abundant in our galaxy, and JWST is showing that we can analyze their atmospheres in detail 65.

It's worth noting that JWST's discovery of methane and carbon dioxide on K2-18b in itself was a milestone 66.

Those detections confirmed that K2-18b's atmosphere contains carbon-bearing molecules and supported the idea of a habitable environment (the presence of CH_4/CO_2 along with the lack of ammonia is what led scientists to propose a water ocean below)67.

That set the stage for looking for potential biosignatures like DMS. In essence, JWST provided a peek into the atmospheric chemistry and conditions of a distant world, something that was simply not possible before.

The telescope's Mid-Infrared Instrument (MIRI), used in the latest observations, is a particularly powerful tool because many complex

molecules have their strongest spectral "fingerprints" in the mid-infrared range. Detecting DMS on an exoplanet was often discussed as a goal for the *next generation* of telescopes, but JWST has brought that goal into the present.

The ongoing analysis of K2-18b demonstrates how JWST is revolutionizing astrobiology. For the first time, we have data that allow scientists to debate not just whether an exoplanet has an atmosphere, but whether that atmosphere shows signs of *life*. Prof.

Chris Lintott frames this discovery as part of a larger journey: rather than a eureka moment, it's a sign that *"the fundamental question of whether we're alone in the universe is one we're capable of answering"* – with sustained effort and advanced tools like JWST .

Each observation JWST makes, whether it confirms a biosignature or finds a mundane explanation, is helping refine our methods and sharpen our understanding of planets beyond the solar system.

The excitement around K2-18b is thus twofold: scientifically, it may be pointing us to the first evidence of alien biology, and technologically, it showcases JWST's game-changing ability to probe exoplanet atmospheres. As

Prof. Madhusudhan reflected, "Decades from now, we may look back at this point in time and recognise it was when the living universe came within reach."[68]

Even if life on K2-18b remains unconfirmed for now, the fact that we can detect potential life-signature gases 120 light-years away is a remarkable step forward. It gives confidence that with continued observations – of K2-18b and other promising worlds – we may eventually find that Earth is not the only living world in the cosmos.

Conclusion

The reported detection of dimethyl sulfide and dimethyl disulfide in K2-18b's atmosphere is a groundbreaking development in exoplanet science. It represents the strongest hint to date of possible life on a distant world, though it is crucially a tentative hint at this stage .69

These molecules, known on Earth to be tied to life, make K2-18b an even more compelling candidate in the search for habitable environments beyond our solar system.

The findings have sparked equal parts excitement and skepticism in the scientific community.

On one hand, we have a plausible biosignature on an exoplanet – something practically unimaginable a decade ago.

On the other hand, scientists are rigorously examining every alternative explanation and insisting on higher confidence data before declaring anything as profound as evidence of extraterrestrial life.

This healthy scientific debate will ensure that if and when we do announce life on K2-18b (or any exoplanet), it will be on rock-solid evidence.

In the coming years, **additional JWST observations** of K2-18b will be critical to either confirm the presence of DMS/DMDS or refute it. Parallel research into the planet's nature (oceanic or not) and possible abiotic chemistry will provide context to interpret the data.

The story of K2-18b is still unfolding, but it has already shown us what is now within reach. We are entering an era where *atmospheric biosignatures* on distant planets are detectable – an era inaugurated by JWST's keen eyes.

Whether or not K2-18b ultimately hosts life, the methods and lessons learned here will pave the way to finding **life elsewhere in the universe**, if it's out there.

As researchers involved noted, this could be remembered as the moment when our **“living universe”** finally came within scientific grasp .70

“Keep watching this space,” as Dr. Subir Sarkar quips – we are just getting started in our exploration of countless other worlds 71.

The tantalizing case of K2-18b shows that the age-old question *“Are we alone?”* is now one we can tackle with empirical observations, and perhaps soon, a definitive answer.

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Sources:

The above report is based on the latest findings from the University of Cambridge team (lead: N. Madhusudhan) on K2-18b's atmosphere, including their April 2025 preprint and JWST data[72], as well as commentary from experts and related news coverage [73]

NASA's press releases and the BBC News report on this discovery were used for direct quotes and context [74].

All information and citations are up-to-date as of 2025, reflecting the current scientific consensus and open questions regarding the potential biosignatures on K2-18b.

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